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UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF AGRICULTURAL ECONOMICS

Operations Guidance Report on

WATER FACILITIES FOR
SOUTH CONCHO RIVER
SPRING AND DOVE CREEK WATERSHED
TEXAS

Prepared by

WATER UTILIZATION SECTION
DIVISION OF LAND ECONOMICS

September 1939

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Under the Provisions of the
Water Facilities Act
(Public Law No. 399, 75th Congress)

September 1939

ACKNOWLEDGMENTS

Special acknowledgment of assistance in obtaining data for this report should be made to the United States Geological Survey; Texas Board of Water Engineers; Bureau of Economic Geology, University of Texas; United States Weather Bureau; and public officials in Tom Green, Irion, and Schleicher counties, Texas.

AUTHORIZATION

This report has been prepared in accordance with the provisions of the Water Facilities Program authorized under the Water Facilities Act, Public Law No. 399, 75th Congress, approved August 28, 1937, and the Secretary of Agriculture's Memorandum of July 1, 1938, on Administration of the Water Facilities Program. On January 18, 1939, the Water Facilities Board authorized this area in southwestern Tom Green County and partially in northwestern Schleicher, southeastern Irion, and northeastern Crockett Counties, Texas, for area planning and operations. Formal notification of the Board's action is contained in Texas State Memorandum No. 3, dated January 19, 1939.

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SUMMARY

The physiographic location of the South Concho River, Spring and Dove Creek basins in West-Central Texas is such that irrigation practice is desirable. Erratic and often low annual precipitation is supplemented by application of diverted stream flow upon the irrigable lands of the several basins.

Currently irrigated land within the basins to which this report relates amounts to 7,360 acres and constitutes slightly less than one per cent of the entire area.

From analysis of all data assembled, the following conclusions and recommendations appear to be justified.

1. The total mean annual yield of the South Concho, Spring and Dove Creek area approximates 64,414 acre-feet. This discharge is produced by a drainage area of 1,407 square miles and is equivalent to a mean annual yield of 45.8 acre-feet per square mile.
2. The mean annual water supply produced by the separate basins involved is estimated as follows:

Stream	Drainage Area	Estimated Mean Annual Discharge	Mean Yield per square mile
South Concho River	604	34,462	57.1
Spring Creek	532	19,844	37.3
Dove Creek	271	10,108	37.3
TOTAL	1,407	64,414	45.8

3. Present irrigation systems serve 1,821 acres of land in the South Concho River basin; 2,520 acres within the Dove Creek watershed; and 2,958 acres in the basin of Spring Creek.
4. Mean annual water supply available in each basin is sufficient in amount to serve adequately the present irrigated acreage.
5. The combined residual yield of the three basins is adequate for fulfilment of the municipal water supply requirements of San Angelo, Texas.
6. Inefficient methods of distributing irrigation water and inadequate maintenance of distribution systems are responsible for excessive transportation losses which often result in the shortage of supply suffered by water users in the lower portions of the basins.
7. No additional irrigation with surface water supply is recommended until such time as cooperative effort by water users establishes a reasonably beneficial utilization of supplies now diverted for purposes of irrigation.
8. Regulation of stream flow by storage is precluded because economically feasible sites for either channel or off-channel reservoirs are not available.

9. Recovery of ground water for irrigation use is not recommended because physically irrigable lands may be more economically irrigated with available surface water supplies.

10. Facilities which recover and use ground water for stock and domestic purposes are in general use throughout the drainage areas considered in this report.

11. Potable ground-water supplies may be recovered for stock and domestic use throughout the Spring and Dove Creek basins and within all except two localized areas in the South Concho River basin. (See Plate 3).

12. In order to obtain a more adequate distribution of stock water, some additional development of facilities for ground water recovery is recommended.

I

INTRODUCTION

Location of Area

The area with which this report is concerned lies principally in southwestern Tom Green County and partially in northwestern Schleicher, southeastern Irion, and northeastern Crockett Counties, Texas. Included within the area are the drainage basins of Spring and Dove Creeks and the drainage area of the South Concho River exclusive of the Middle Concho River basin. Bounding the area to the north is the watershed of the Middle Concho River; adjacent, on the south, is the San Saba River basin, and joining the area on the west is the drainage basin of the Devil's River, a tributary of the Rio Grande.

Specifically the area to which this report relates lies between latitudes 31°00' and 31°30', and between longitudes 100°30' and 101°15'. The entire area includes approximately 1,407 square miles or about 900,000 acres.

No cities of importance are located within the area itself but San Angelo, Texas is situated about five miles from the northeast extremity of the area boundary. San Angelo has a population of some 25,000 persons and serves as the principal trading center for much of the area considered in this report.

Purpose of Report

For the past fifty years irrigation works of some description have been operated in the basins of Spring and Dove Creeks and the South Concho River. Recent years of extended drought in western Texas have served to intensify public interest in the use of irrigation enterprises.

Over-appropriation and misuse of water resources in an area not endowed with an abundant water supply is common in many of the western arid regions. The South Concho, Spring and Dove Creek area is no exception. Consequently, it is the purpose of this report to appraise the resources of the area concerned, consider their present uses and suggest, if possible, such changes in use of resource or development of unused resources as may be economically feasible for and beneficial to the people of the area.

Scope of Report

The report is of preliminary nature because of the limited time spent in supplementary field study.

There are four parts included in the report. Part I is introductory. Part II is an inventory and appraisal of the physical factors and conditions which necessarily form the basis of and impose the limitations upon utilization of the area.

Factors appraised in this section of the report are those which must be considered in the planning for more beneficial use of resources available within the area. Present use of lands and waters in the area are discussed in Part III. In Part IV are presented such adjustments in present area use and potential developments in utilization as may be beneficial to the agricultural welfare of the area and conducive to the economic stability of its peoples.

II

PHYSICAL INVENTORY

General Description

The South Concho River, Spring and Dove Creek basins are typical of the drainage areas throughout the most southerly portion of the Great Plains. All three streams have their origin along the northern escarpment of the Edwards Plateau at elevations varying from 2,300 to 2,800 feet. The South Concho River rises near Eldorado, Texas and flows generally northward for a distance of about 40 miles to its confluence with the Middle Concho River at the inlet to Nasworthy Lake six and one-half miles south of the city of San Angelo, Texas. Spring Creek has its origin near the town of Barnhart, Texas and flows in a slightly northeasterly direction for some 50 miles until it joins the Middle and South Concho Rivers at Lake Nasworthy.

Dove Creek originates between the headwaters of Spring Creek and the South Concho, flows to the northeast for 30 miles and enters Spring Creek about 7 miles upstream from the confluence of Spring Creek and the South Concho River. All of the streams consequently flow into Lake Nasworthy at an elevation of approximately 1,900 feet.

The drainage areas of the several streams are much the same in character with some rough to rolling land near the headwaters, slightly rolling lands and rather broad alluvial valleys in the central and lower portions of the basins. The central and lower basins contain the principal bodies of irrigated land while the higher and headwater areas embrace the livestock grazing regions.

Stream channel gradients are rather uniform throughout the length of those portions of the streams above San Angelo. Fluctuations in stream flow are rapid and the variation is from little or no discharge to extreme and destructive floods. Several miles below the headwater drainage of each stream, and at the base of the Edwards Limestones, perennial springs discharge their waters to the stream beds. These spring flows vary somewhat from year to year and from season to season, but are usually sufficient, together with return flow, to furnish the greater part of the divertable water supply for irrigation use.

Topography

As a generalization the topography of the South Concho, Spring and Dove Creek area may be considered as undulating to roughly rolling. More specifically, however, the area might be divided into three topographic regions: (1) rough hilly regions,

(2) plateau regions, and (3) river valleys. The rough hilly region covers the outer extremities of the area along the north and west sides of the Spring Creek basin. The plateau region almost totally bounds the area to the south and southwest and is a broad, flat region composed of the Cretaceous Edwards Limestone. The rivers have formed but few alluvial terraces and these are relatively broad and lie only slightly higher than the stream beds themselves.

Drainage patterns of the several streams and their tributaries are well defined although none of the rivers discussed have entrenched themselves in deep or canyon-like valleys. The valleys are broad and of sufficiently low gradient to preclude practicable channel or off-channel storage. Stream diversions, however, may be and are made for distribution of water on lands. Readily irrigable lands, for which water is available, are limited to those low-lying, level terraces immediately adjacent to the streams in the lower valleys.

Precipitation

Records of precipitation are collected by the United States Weather Bureau at two stations, one in and one adjacent to the drainage basins herein discussed. A 49-year record of precipitation at San Angelo, Texas, shows an annual mean rainfall of 21.90 inches, while a record at Knickerbocker, Texas, obtained over a 28-year period shows a mean annual precipitation of 19.18 inches.

Although the annual mean is not extremely high, the area is subject to frequent storms of short duration and high intensity. Occasionally an isolated storm is responsible for 50 per cent or more of one year's total precipitation. For example, in September 1936 San Angelo received 27.65 inches of rain, while during the other months of the calendar year only 12.75 inches of precipitation occurred. On September 15 of the same year San Angelo received 11.75 inches in 24 hours. In one 24-hour period, August 6, 1906, Knickerbocker, Texas, had a 7.87-inch rainfall. Rains totaling as high as 24 inches in 21 hours have been reported unofficially from basins adjacent to those under consideration. These reports, however, are not considered as being highly reliable.

The following tables show the mean monthly and annual precipitation at San Angelo and Knickerbocker, Texas.

Table 1
Average Precipitation at
San Angelo, Tom Green County, Texas

Record: 49 years

Elevation: 1,847 feet

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Precipitation in inches	0.84	1.00	0.82	1.92	3.06	2.02	2.03	2.41	3.18	2.08	1.28	1.26	21.90
Per cent of annual Av. Precipitation	3.8	4.6	3.8	8.8	14.0	9.2	9.2	11.0	14.5	9.5	5.8	5.8	100.0

Table 2
Average Precipitation at
Knickerbocker, Tom Green County, Texas

Record: 28 years

Elevation: 2,050 feet

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Precipitation in inches	0.68	0.84	0.87	2.08	2.31	1.76	1.41	2.33	2.24	2.42	1.26	0.98	19.18
Per cent of annual Av. Precipitation	3.5	4.4	4.5	10.8	12.0	9.2	7.4	12.2	11.7	12.6	6.6	5.1	100.0

Table 3
Temperature and Growing Season

Station	County	Years of Record	Temperature					Growing Season	
			Mean Annual	Av. Max. Daily July	Av. Min. Daily January	Recorded Max.	Recorded Min.	Average date last killing frost	Number of days
Big Spring	Howard	35	63.9	96.1	29.5	117	-7	4/1	222
Ft. McKarett*	Menard	55	64.7	97.1	29.5	114	-6	3/31	223
Garden City	Glasscock	12	—	—	—	—	—	4/8	210
Knickerbocker*	Tom Green	28	65.4	96.9	32.3	113	-6	4/5	215
Midland	Midland	25	62.9	95.8	27.2	116	-1	3/31	217
Robert Lee*	Coke	12	63.8	—	—	—	—	—	—
San Angelo	Tom Green	45	64.0	97.1	31.7	111	1	3/25	231

* Station discontinued

Years of record shown are of annual mean temperature (not necessarily continuous years).
All data are as of January 1, 1938 — From U. S. Weather Bureau records.

Temperature

United States Weather Bureau records of temperature an growing season at a number of stations in and near the area concerned are also given in the above table.

Evaporation

Data on monthly and annual evaporation are collected at only scattered points throughout the State of Texas. Consequently, the records presented can be considered as merely indicative, since no data are available for the area itself. Following is an evaporation record taken at the United States Field Experiment Station, Big Spring, Texas, some 90 miles from the South Concho, Spring and Dove Creek areas.

Mean Monthly Evaporation, in inches
at Big Spring, Texas - April to Sept.
1916 - 1932

Mean	April	May	June	July	August	Sept.	Total
	7.419	8.813	10.202	11.011	10.178	7.538	55.161

This record has been extended and a figure for annual evaporation calculated[1] which indicates a yearly evaporation of about 76 inches.

Because annual precipitation is greater and mean annual temperature slightly less in the area to which this report relates, it is logical to assume that the gross annual evaporation

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[1] Texas Agricultural Experiment Station Bulletin 484, p. 21.

somewhat less. From data available this gross annual evaporation is estimated at 70 inches.

Wind Movements

Records of prevailing wind direction only are available from the United States Weather Bureau Stations at San Angelo and Knickerbocker, Texas. Average wind movement may be indicated from a record taken at Abilene, Texas.

Wind direction and movement records are given in the following tabulations.

Prevailing Wind Direction

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Av.
San Angelo	N	N	S	S	S	S	S	S	S	S	S	N	S
Knicker-bocker	S	S	S	S	S	S	S	S	S	S	S	S	S
Abilene	S	S	S	S	S	S	S	S	S	S	S	S	S

Average Wind Movement in miles per hr.

Abilene	9.9	10.8	11.8	12.0	11.1	10.5	8.9	8.2	8.6	9.0	9.3	9.6	10.0

Maximum Wind Velocity and Direction
with Date of Occurrence

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yr.
Abilene													
M.p.h.	60	61	50	60	66	62	60	48	46	40	48	60	66
Direct.	W	W	SW	SE	SW	NE	SW	SE	NE	NW	NE	W	SW
Year	1893	1912	1895	1888	1892	1888	1889	1886	1920	1895	1895	1890	

Geology

There are several of the geologic formations in the South Concho, Spring and Dove Creek area which directly or indirectly affect both ground and surface water supplies of the area. The following table shows the sequence of formations within the area.

Period	Series	Formation	Character
Quaternary	Recent		Stream deposits; chert, gravel, sand, silt.
	Pleistocene		Alluvial terraces - mainly silt and sand.
Cretaceous	Washita Group	Buda Grayson Georgetown	Sandy, nodular limestone Marl and sandy limestone Nodular limestones - marly beds
	Fredericksburg Group	Edwards Comanche Peak Walnut	Massive cherty limestone Sandy limestone and marl Sandy clays and marls
	Trinity Group		Soft sand, concretionary sandstones and red and white clays. Partly cemented.
Permian	Double Mountain	Blaine	Gypsiferous, limy sandstones and shales. Thin layers of green clay.
		San Angelo	Red sandstones and shales. Some gypsum. Conglomerate at base.

The areal extent of exposed formations is shown on Plate 2 and the following discussions concern each formation as it relates to water supply.

Quaternary:

Recent silts, sands and gravels, which have been released by disintegration of Pleistocene sediments, cover the stream in the lower portions of the basins. These deposits vary in thickness from zero to about 25 feet but are of little importance in relation to water supplies.

Pleistocene.--A medium to coarse conglomerate of limestone and cherty gravels covers rather extensive areas, in the form of terraces, along the courses of the South Concho River, Spring and Dove Creeks. In relation to water supply, the Pleistocene conglomerate assumes importance as an aquifer through which return flow waters revert to the stream beds. Calcareous cementation is common throughout the formation, but to a degree which does not impair the movement of ground or return flow waters.

Cretaceous:

Washita Group.--The Buda, Grayson, and Georgetown formations combined are referred to as the Washita Group. Within the area to which this report relates, formations of the Washita Group are of little importance hydrologically. Erosion has removed the greater part of these formations, although thin layers of the group are found resting upon the Edwards formation which forms the major portion of surface exposure on the plateau surrounding the headwaters of the basins involved. On Plate 2

it will be noted that the Edwards Plateau is shown to be overlain with sediments of the Washita Group.

Fredericksburg Group.—The uppermost formation of the Fredericksburg Group is the Edwards Limestone. The basins of the South Concho River, Spring and Dove Creeks are bounded on the southeast, south, and west by the escarpment of the Edwards Plateau. Because the Edwards formation is composed of massive, cavernous limestone beds it is a most competent aquifer and hence assumes an important place in relation to the water supplies of the area. The flat, almost featureless surface character of the Edwards Plateau combined with the highly permeable character of the limestone is conducive to the intake of a considerable quantity of water which falls as precipitation upon the plateau. This natural recharge to the formation is counterbalanced by a natural discharge from it. A part of the discharge appears as surface water in the surface streams of the area and the remaining portion is discharged through evaporation and transpiration along the outcrop. Discharging springs are found on all three streams at or near the base of the Edwards formation. Such discharge forms the perennial base flow of the South Concho River, Spring Creek and Dove Creek.

The Comanche Peak and the Walnut clay formations are also members of the Fredericksburg Group. The Comanche Peak formation lies below the Edwards and above the Walnut clay and is composed of soft, chalky limestones. The Walnut clay is composed of soft,

marly sands and sandstones which are highly erosive. Past erosion has removed much of the formation and remnants now form only a break or divider of a few feet in thickness between the overlying Comanche Peak and the underlying Trinity.

Both formations are sufficiently permeable to carry and to yield potable ground water in sufficient quantities for stock or domestic use.

Trinity.—The Trinity sands lie unconformably upon Permian strata and are exposed in the lower basins of the streams in the area. The Trinity beds are a conglomerate of sands and sandstones which form a competent aquifer. With few exceptions the Trinity carries potable water readily recoverable for stock and domestic purposes. In a few local areas, particularly in the South Concho basin near Christoval, waters recovered from Trinity sands are not potable. This is probably due to the entrenchment of Trinity sands in the cavernous, uneven surface of the lower lying Blaine formation whose waters are saline and gypsiferous and which would readily contaminate the Trinity water by lateral infiltration.

Permian:

Double Mountain.—Only small portions of the Blaine and and San Angelo formations are exposed within the area considered in this report. The areal exposures are shown on Plate 2. Both formations are composed of gypsiferous sandstones with seams of

clay and shale. Some water is carried by each formation but, within the area herein considered, the quantity is sufficiently small and the quality so poor that neither formation is significant in relation to the water supplies of the area.

Soils[1]

Along the alluvial bottoms of the South Concho River, Spring Creek, and Dove Creek, occur the soils of the Frio and Leona series. The terraces and rolling lands of the basins are generally mantled with the soils of the Roscoe group. The larger part of the basins, particularly the central and upper portions, are characterized as rough stony land and generally the principal soils are the Valera series.

Because the streams of the area are confined to rather narrow valleys there are no large bodies of alluvial soil. However, narrow strips of alluvial soil are present in places. These soils belong chiefly to the Frio and Leona series.

Frio soils are composed of materials washed from the limestones of the Edwards Plateau and are light-brown calcareous

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[1] Carter, W. T., The Soils of Texas, Texas Agr. Expt. Sta., Div. of Soil Survey, Bull. 431, July 1931.

of granular structure. Frio soils lying near the streams are usually underlain by beds of sand or gravel and have fairly rapid surface drainage and free underdrainage. These soils are highly productive and are well suited to general farm crops and to some fruits. Their sub-soils afford a good reservoir for soil moisture which consequently characterizes them as good drought resistant soils.

Leona soils are dark-brown calcareous top soils and are generally granular and fairly deep. The soil material has been in part washed from the Edwards Plateau soils, and consequently contains some limy material from the limestone of the Edwards formation. The soils are productive and suited to general farm crops.

Most of the soils of the middle basins, and of the rolling lands therein, are composed of soils of the Roscoe series. These soils have brown or dark-brown surface soils with a lighter brown sub-soil. The sub-soils merge with a calcium carbonate of highly calcareous chalky clay. The chief soils of this series are of clay or clay loam textures. They are well suited to cotton, corn, grain sorghum, and other general farm crops. The Roscoe series are somewhat limited in extent and are generally associated with the Abilene soils.

The top soils of the Abilene are brown to dark-brown in color and as a rule the soils themselves and the upper sub-soils are not calcareous. The soils themselves are granular and,

though heavy, are fairly open and permeable in character. Generally, soils of this series are deep clay loams. Soils of the Abilene series are very productive and are extensively utilized for general farm crops.

In the upper portions of the South Concho River, Spring and Dove Creek basins, much of the area is mantled with soils of the Valera series. In general the Valera soils are mostly shallow and calcareous, with its principal type being stony clay. However, some areas of clay and clay loam occur in smoother localities. Along the steeper slopes many places are so eroded and stony that they are included with the type of land classified as rough stony land. The deeper soils of the Valera are clays and clay loams and are fairly productive under favorable moisture conditions. Most of these soils are in ranches on which cattle, sheep, and goats graze on the native vegetation.

Hydrology - Surface Water Supply

The surface water supply available to the area under consideration has its origin on the drainage areas of Dove Creek, Spring Creek, and the South Concho River and is derived from two sources: (1) surface run-off from the drainage areas themselves, and (2) ground-water discharge to the surface streams. As

previously mentioned in the sections of this report covering "Physiography" and "Geology," it was pointed out that there are rather extensive areas of the Edwards Plateau adjacent to the upper drainage patterns which do not contribute surface run-off to the streams. Due, however, to the highly permeable character of the Edwards limestones, these areas act as a competent recharge intake to the ground-water body of the Edwards formation in the basins involved. Discharge from this source of water supply appears as springs near the base of the Edwards on all three of the streams in the area.

Quantitative estimates of available water supply may be made from data available relevant to the discharge of the various streams. Records of stream measurements have been compiled by the United States Geological Survey at several stations in and near the area to which this report relates. A gaging station has been maintained on the Concho River below San Angelo, Texas, since September 1915; on the South Concho one mile above the confluence of the North Concho, from October 1931 to date; on the South Concho River at Christoval, Texas, since February 1930; on Spring Creek, two and three-fourths miles above confluence with the Middle Concho River, from February 1930 to present date; on the Middle Concho River near Tankersly, Texas, for the same period as the Spring Creek gage; and on the North Concho River, two miles above Carlsbad, Texas, since March 1924. No measurements are made

for Dove Creek alone, but its discharge is included in the record of flow at the Spring Creek station.

All of the available discharge records are considered good. However, low flow at the stations on the South Concho and Main Concho near San Angelo is affected by upstream diversion and storage for irrigation and municipal use.

From Plate 3 it may be seen that the area with which this report is concerned includes the drainage areas of Spring and Dove Creeks and the drainage area of the South Concho River down to its entrance into Nasworthy Lake. Shown also on Plate 3 are the locations of gaging stations which are applicable to the streams discussed herein. It should be noted that the Middle Concho River is not included in the area and hence, the discharge measurements tabulated herein are corrected to exclude from consideration the discharge of the Middle Concho River.

The following tables show the monthly and annual discharges of the South Concho River at a point about one mile above its confluence with the North Concho River in the city of San Angelo, Texas, and the monthly and annual discharges of the Middle Concho River near Tankersly, Texas.

Table 4
Discharge of South Concho River
near San Angelo, Texas,
in acre-feet
Contributing drainage area - 2535 square miles

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Ann.
1932	14	65	282	2400	2320	1620	4260	78,100	7260	29,600	916	24,400	151,200
1933	8420	7200	7380	7440	5450	3970	1850	2,660	395	818	12	0	45,600
1934	270	534	569	922	1660	1800	6960	726	297	1,370	334	22	15,700
1935	0	61	1100	157	4070	274	1740	53,250	27840	5,590	23	24,890	119,000
1936	3470	4640	2770	2250	716	1670	627	9,410	448	707	1460	*	*28,200
Mean	2435	2500	2420	2634	2843	1867	3087	28,830	7248	7,657	549	12,328	74,396

*Extreme flood flow of Sept. 1936 not included in the record nor in the mean.

Table 5
Discharge of Middle Concho River
near Tankersly, Texas,
in acre-feet
Contributing Drainage Area - 1128 square miles

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Ann.
1932	0	0	0	0	0	0	797	47,000	3140	7130	181	11,700	69,950
1933	1440	952	1570	1400	1120	1070	720	397	18	0	0	0	8,490
1934	0	0	0	0	0	0	146	0	154	0	1860	0	2,160
1935	0	1880	0	0	5320	0	2530	20,940	9500	2260	490	1,420	44,140
1936	0	0	0	46	22	0	0	10,950	336	114	0	*	*11,470
Mean	288	566	274	289	1292	214	839	15,857	2590	1900	506	3,280	27,895

*Extreme flood flow of Sept. 1936 not included.

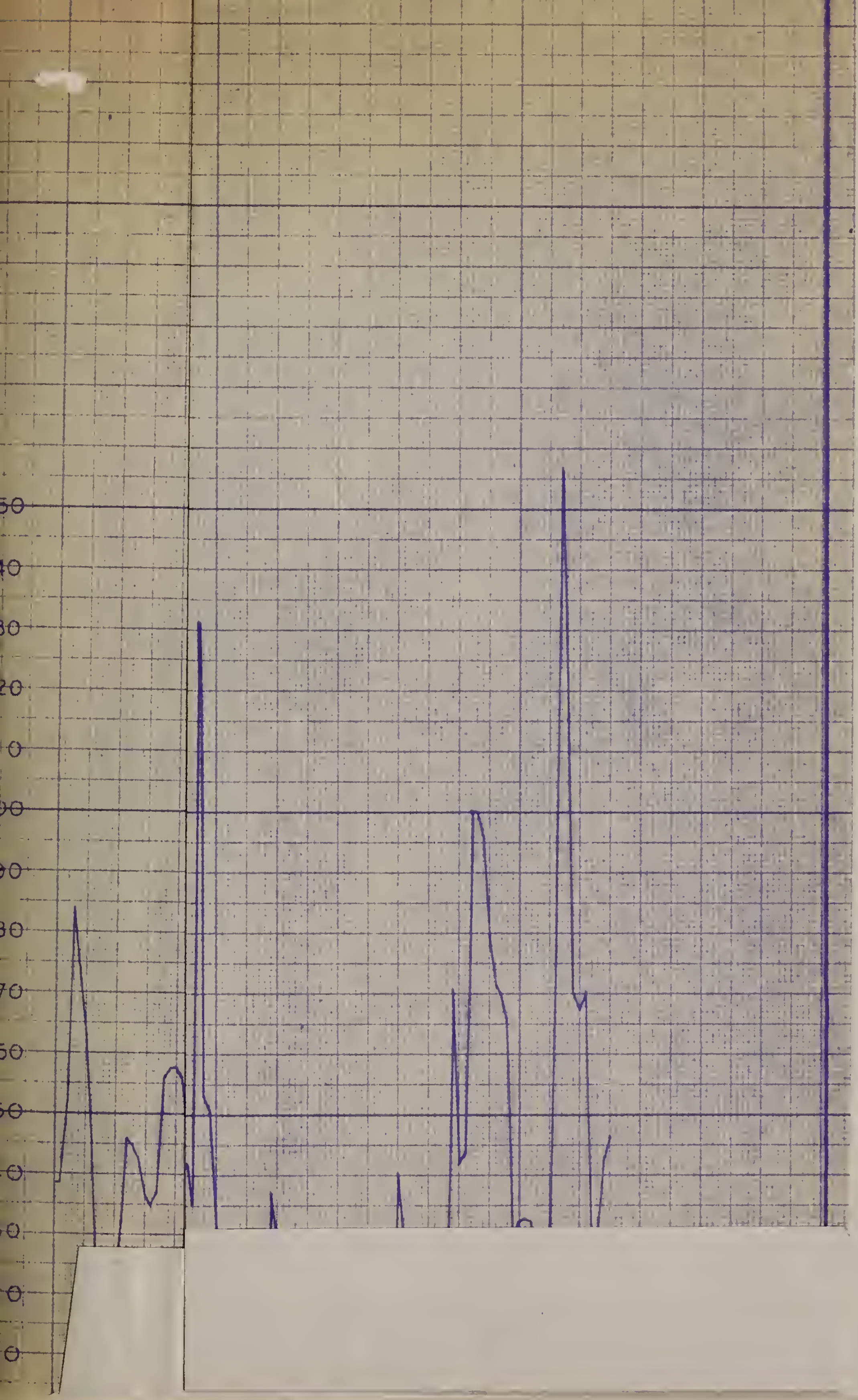
HYDROGRAPH

SHOWING

MEAN DAILY DISCHARGE OF CONCHO RIVER

IN SECOND FEET

SAN ANGELO, TEXAS
1924–1936



Texas, is used for the basins of Spring and Dove Creeks.

HYDROGRAPH

SHOWING

MEAN DAILY DISCHARGE OF SOUTH CONCHO RIVER

IN SECOND FEET

SAN ANGELO, TEXAS
1932-1936

As previously stated, the area under consideration does not include the Middle Concho River. Hence, for the purpose of this report, the mean monthly and annual discharge of the South Concho near San Angelo is corrected to exclude the discharge of the Middle Concho above Tankersly and the net mean monthly and annual discharge from the drainage areas concerned are given in the following tabulation.

Table 6

Mean Discharge
of
South Concho River including Spring and Dove Creeks
and including the Middle Concho River
measured near
San Angelo, Texas,
in acre-feet
1932 - 1936
Contributing drainage area - 1,407 sq. mi.

Oct. - 2,147
Nov. - 1,934
Dec. - 2,146
Jan. - 2,345
Feb. - 1,551
Mar. - 1,653
Apr. - 2,248
May - 12,973
June - 4,658
July - 5,757
Aug. - 41
Sept.- 9,048
Annual - 46,501

Although the above record includes no corrections for diversion and storage above the gaging station, it is assumed that the mean annual discharge of 46,500 is a conservative estimate of the mean annual residual yield from the three basins considered. Later in this report several factors affecting the discharge of the South Concho are discussed at length and a more detailed statement relating to the amount of discharge is included therein.

In order to show the total amount, distribution and seasonal availability of water supply for irrigation use, the recorded discharge of the South Concho River at Christoval, Texas, is used for that basin and the record of flow in Spring Creek near Tankersly, Texas, is used for the basins of Spring and Dove Creeks.

The following record shows monthly and annual discharge of the South Concho River at Christoval, Texas:

Table 7
Discharge of South Concho River at Christoval, Texas, in acre-feet

Contributing drainage area - 434 square miles

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Ann.
1932	611	594	781	1160	840	984	714	4100	1520	5160	984	3280	20,730
1933	2830	2510	2130	1970	1670	1710	1120	1090	672	592	615	476	17,400
1934	474	637	484	523	605	762	1860	584	134	143	1830	356	8,420
1935	285	352	301	268	537	346	563	7750	5550	527	1330	9330	27,140
1936	1920	1370	1210	1190	1090	1110	924	514	293	408	220		10,250
Mean	1224	1093	981	1022	948	982	1036	2808	1644	1366	996	3356	17,456

Extreme flood discharge of Sept. 1936 not included.

The gaging station at Christoval, Texas, is located about 600 feet downstream from the headworks of a canal which diverts water for irrigation throughout the year. Consequently, the record of flow in the South Concho at Christoval must be corrected for such diversion. Miscellaneous measurements[1] of the water so diverted have been made and are given, hereafter, to indicate the amount of correction to be made in the South Concho record:

Table 8
Miscellaneous Measurements of flow in Irrigation Canal above Christoval, Texas — Second-feet

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1932			14.3		4.79		8.19			11.1		
1933	6.53			7.63		5.96		11.6	17.3	13.9	11.9	
1934	11.7	9.64	11.8	12.2	8.6		10.7	14.1	13.9	14.2	12.3	14.5
1935	12.8		8.18	9.14	5.03	10.7	9.23	14.2	6.62		16.0	
1936	15.6	16.4	11.8		10.8		9.62	16.1	12.7	13.4	13.7	
Mean	11.65	13.02	11.52	9.66	7.32	8.33	9.47	14.00	12.63	13.15	13.48	14.5
Mean Ac-Ft	23.10	25.82	22.84	19.16	14.52	16.52	18.78	27.76	25.05	26.08	26.73	28.75
Mean Ac-Ft per Mo.	716	775	708	594	407	512	563	861	752	809	829	863

Annual Total - 8389 acre-feet

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[1] U.S.G.S., W.S. Papers, Western Gulf Section.

Since the above record is not continuous it can be considered only as a general estimate of the monthly diversions through the canal in question. Because, however, it is the only data available it is considered sufficiently indicative to allow its use in correction of the South Concho discharge at Christoval.

Below is given a tabulation of the mean monthly and annual discharge measurements, corrected upon the basis of the diversions indicated in the previous tabulation:

Table 9
Mean Monthly and Annual Yield
of
South Concho River at Christoval, Texas,
in acre-feet
Drainage Area - 434 square miles

Oct. - 1,940
Nov. - 1,868
Dec. - 1,689
Jan. - 1,616
Feb. - 1,355
Mar. - 1,494
Apr. - 1,599
May - 3,669
June - 2,396
July - 2,175
Aug. - 1,825
Sept. - *4,219
Annual - *25,845

*Extreme flood discharge of Sept. 1936 not included.

On the basis of the adjusted means, as shown above, the mean annual yield of the South Concho River basin above Christoval, Texas, is 25,845 acre-feet and is equivalent to a yield of 59.6 acre-feet per square mile.

The combined discharge of Spring and Dove creeks is obtained from the records of a gaging station on Spring Creek below the confluence of the two named streams.

Following is the record of Spring Creek discharge below the town of Tankersly, Texas:

Table 10.
Monthly and Annual Discharge
of
Spring Creek near Tankersly, Texas ,
in acre-feet
Drainage Area - 734 square miles

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1932	1	140	885	1380	828	726	4460	24,400	2420	14800	879	8330	59,250
1933	4460	3490	3740	3490	2420	1790	1100	1190	132	19	3	2	21,840
1934	279	1430	1040	1380	1460	793	2050	172	217	6	0	0	8,850
1935	0	169	404	282	944	319	729	9570	9620	2740	526	8000	35,300
1936	1570	1860	1420	1020	454	259	56	1320	1020	569	13	*	9.560
Mean	1262	1418	1498	1510	1221	777	1679	7330	2682	3627	284	4083	27,371

*Flood flow of Sept. 1936 excluded.

The mean annual yield of Spring Creek, on the basis of the records shown, amounts to 37.3 acre-feet per square mile of drainage area above the recording station.

Because of diversion and application of waters for irrigation of lands adjacent to the South Concho River, Spring and Dove creeks, water in excess of consumptive use, returns to the stream beds by lateral underground percolation downstream from the lands on which it is originally applied. Such return flow is thus available for re-diversion to other irrigated lands further downstream.

Seepage and return flow measurements on the streams involved[1] were made in 1925 and are indicative of the quantities of water so returned to each of the streams in the area considered.

Measurements were also made in the early spring of 1939 during the course of field investigations made in connection with this report.

Tabulations are included below giving the various measurements made for quantitative determination of return flow waters.

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[1] U. S. Geological Survey, W. S. P. 608.

Table II

Discharge measurements to determine seepage on Spring Creek from Seven Springs above Mertzon, Texas, to mouth. March 1925.

Date	Stream or Diversion	Location	Approx. dist. in miles from initial point	Discharge in second-feet				
				Main stream	Tributary	Diversion	Gain or loss in sec.	Total gain, cummulative
Mar. 6	Spring Creek	Just above Seven Springs, Mertzon, Tex.	0	0.7	—	—	—	—
Mar. 6	Spring Creek	Just below Seven Springs	0.1	12.2	11.5	—	+11.5	+11.5
Mar. 6	Diversion	Mertzon, Texas	3	—	—	7.8	—	—
Mar. 6	Spring Creek	Mertzon, Texas	3	5.4	—	—	+ 1.0	+12.5
Mar. 6	Diversion Middle Ditch Dam	1.5 mi. below Mertzon	4.5	—	—	2.7	—	—
Mar. 7	Spring Creek	3.7 mi. below Mertzon	6.7	7.5	—	—	+ 4.8	+17.3
Mar. 7	Spring Creek	Tankersly-Sherwood Crossing	10.6	8.0	—	—	+ 0.5	+17.8
Mar. 7	Spring Creek	2.2 mi. above Tankersly	14.3	4.4	—	—	- 3.6	+14.2
Mar. 7	Spring Creek	1.2 mi. above Russell Dam	16.5	4.8	—	—	+ 0.4	+14.6
Mar. 7	Spring Creek	Russell Dam	17.7	0	—	—	—	—
Mar. 9	Spring Creek	0.1 mi. above mouth of Dove Creek	18.7	0.8	—	—	+ 0.8	+15.4
Mar. 9	Elliott's Pump	0.2 mi. below mouth of Dove Creek	19.0	—	—	3.1	—	—
Mar. 9	White's Pump	0.2 mi. above Motel Dam	19.6	—	—	1.9	—	—
Mar. 9	Motel Ditch	Motel Dam	19.8	—	—	6.2	—	—
Mar. 9	Spring Creek	Below Motel Dam	19.9	0.2	—	—	+10.6	+26.0
Mar. 9	Spring Creek	3.9 mi. below Dove Creek	22.7	2.4	—	—	+ 2.2	+ 28.2
Mar. 9	Spring Creek	Mouth	26.5	4.6	—	—	+ 2.2	+30.4

Table 12

Discharge measurements to determine seepage on South Concho River from Christoval, Texas, to mouth. March 1925.

Date	Stream or Diversion	Location	Approx. dist. in miles from initial point	Discharge in second-feet				
				Main stream	Tributary	Diversion	Gain or loss in sec.	Total gain, cumulative
Mar. 12	South Concho River	Main spring	0	10.7	—	—	—	—
Mar. 12	Mill Spring	1 mi. above Christoval	4	—	2.4	—	—	—
Mar. 12	South Concho River	Christoval	5	21.6	—	—	+ 8.5	+ 8.5
Mar. 12	Diversion of Christoval Dam	Christoval	5	—	—	8.0	—	—
Mar. 13	Return water from Christoval Dam	- - -	9.1	—	1.8	—	—	—
Mar. 13	Diversion of Broome Dam	500 feet below Pecan Creek	14.4	—	—	19.6	—	—
Mar.13	South Concho River	Below Broome Dam	14.4	8.4	—	—	+12.6	+21.1
Mar. 13	Return water from Broome Dam	2 mi. below Pecan Creek	16.4	—	7.1	—	—	—
Mar. 13	Return water from Broome Dam	2.3 mi. below Pecan Creek	16.7	—	5.4	—	—	—
Mar. 14	South Concho River	New City Dam	20.8	19.6	—	—	-1.3	+19.8
Mar. 16	South Concho River	New City Dam	20.8	22.3	—	—	—	—
Mar. 16	South Concho River	Mouth	24.8	19.4	—	—	-2.9	+16.9

Table 13
Discharge measurements to determine seepage on Dove Creek from a point nine miles above Knickerbocker, Texas, to confluence with Spring Creek, March 1925.

Date	Stream or Diversion	Location	Approx. Dis. in miles from initial point	Discharge in second-feet			
				Main Stream	Diversion	Gain or loss in sec.	Total gain, cumulative
Mar. 4	Dove Creek	Source	0	13.0	—	—	—
Mar. 4	Diversion	Above Stilson Dam	0.9	—	11.7	—	—
Mar. 4	Dove Creek	Below Stilson Dam	1.1	0.7	—	-0.6	-0.6
Mar. 4	Diversion	San Jose Dam	3.9	—	4.1	—	—
Mar. 4	Dove Creek	0.5 mi. below San Jose Dam	4.4	8.6	—	+12.0	+11.4
Mar. 5	Dove Creek	0.5 mi. below San Jose Dam	4.4	7.6	—	—	—
Mar. 5	Diversion	Baze Dam	8.5	—	4.5	—	—
Mar. 5	Dove Creek	Knickerbocker, Texas	8.7	8.9	—	+5.8	+17.2
Mar. 5	Dove Creek	Above mouth	11.8	8.4	—	-0.5	+16.7

Table 14
Discharge Measurements to determine return flow through irrigated section in South Concho River March 1939

Date	Stream or Diversion	Location	Approx. Dis. in miles from initial point	Discharge in Second-feet: Main Stream	Discharge in Second-feet: Di-version	Discharge in Second-feet: Gain or loss in sec.	Discharge in Second-feet: Total gain, cumu-la-tive
Mar. 25	South Concho R.	Just below Christoval, Tex.	0	30.5	—	—	—
Mar. 25	*Diversion	Christoval Dam Christoval, Tex.	1.0	—	6.2	—	—
Mar. 25	South Concho R.	2.5 mi. below mouth Pecan Cr.	12.0	33.2	—	+8.9	+8.9

* Only one diversion in operation at time of measurements.

Table 15
Discharge measurements to determine return flow through irrigated section on Spring Creek, March, 1939

Date	Stream or Diversion	Location	Approx. Dis. in miles from initial point	Discharge in Second-feet: Main Stream	Discharge in Second-feet: Di-version	Discharge in Second-feet: Gain or loss in sec.	Discharge in Second-feet: Total gain, cumu-la-tive
Mar. 21	Spring Creek	Just below Upper Ditch Dam	0	8.9	—	—	—
Mar. 21	Diversion	Middle Ditch Dam below Mertzon	1.5	—	1.8	—	—
Mar. 21	Diversion	Lower Ditch Dam	13.5	—	4.2	—	—
Mar. 21	Spring Creek	Just below mouth of Dove Creek	15.5	9.1	—	+6.2	+6.2

Table 10
Discharge measurements to determine return flow through irrigated section on Dove Creek, March 1939

Date	Stream or Diversion	Location	Approx. Dis. in miles from initial point	Discharge in second-feet: Main Stream	Discharge in second-feet: Diversion	Discharge in second-feet: Gain or loss in sec.	Discharge in second-feet: Total gain, cumulative
Mar. 23	Dove Creek	300' below spring at source	0	8.6	---	---	---
Mar. 23	Diversion	Above Stillson Dam	1.0	---	3.7	---	---
Mar. 23	Diversion	Tweedy Dam (San Jose Irrig. Co.)	3.8	---	4.8	---	---
Mar. 23	Dove Creek	Below Knickerbocker, Texas	---	6.0	---	+5.9	+5.9

Earlier in this section of this report it was shown that the mean annual residual yield of the South Concho River, Spring and Dove creeks has been about 46,500 acre-feet for the period of record available, ie., 1932 to 1936. As may be noted on Plate 3 the measurements used to determine such yield were taken at gaging stations No. 2 and No. 3 and the figure 46,500 obtained by deduction of the annual mean at station No. 3 from the annual mean at station No. 2. However, station No. 2 is located on the South Concho below Lake Nasworthy and consequently records only the discharge through Lake Nasworthy outlet or over the spillway. No storage register is kept on the volume of water impounded in the Lake. Consequently, the annual volume of stored water must be estimated from existing discharge measurements obtained above and below the reservoir.

By combining the recorded discharges of Spring Creek near Tankersly, Texas, and the South Concho River at Christoval, Texas, it is found that the total mean annual discharge from these combined drainage areas - 1,168 square miles - is 53,216 acre-feet, or 45.6 acre-feet per square mile of drainage area. However, the total drainage area down to the gaging station below Nasworthy Lake is 1,407 square miles; hence, 239 square miles of drainage basin unaccounted for between the upper and lower gages. Assuming that the yield per square mile from that area is the same as the yield from the areas gaged, there should be added an annual increment of 10,898 acre-feet. On this basis the total yield at the reservoir site would be 53,216 acre-feet plus the increment of 10,898 acre-feet or 64,414 acre-feet. The storage capacity of Lake Nasworthy is 10,500 acre-feet which, if deducted from the total yield, would show an annual surplus below the reservoir of 53,614 acre-feet. As previously shown the mean annual discharge of the South Concho River below Lake Nasworthy and near San Angelo, Texas, (station No. 2 - Plate 3) is 46,500 acre-feet, hence, the estimated yield at the reservoir exceeds the surplus gaged below the outlet by 7,114 acre-feet. However, Lake Nasworthy storage is used for the municipal water supply of San Angelo, Texas, a city of about 25,000 population. Assuming a consumption of 150 gallons per capita per day the annual municipal use would approximate 4,200 acre-feet. Industrial uses and natural reservoir losses, probably offset in part by ungaged and thus unaccountable return flow, would logically account for the remaining

difference between the estimated total yield and the measured surplus.

Stream measurements used as a basis for the preceeding analysis are shown in the following tabulations:

Table 17

Net Mean Monthly Discharge
in Acre-feet—1932 - 1936
South Concho, Spring, and Dove Creeks near
San Angelo, Texas, below Nasworthy Lake
(South Concho River at San Angelo minus Middle Concho at Tankersly)
Contributing drainage area — 1407 square miles

Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Ann.
2147	1934	2146	2345	1551	1653	2248	12,973	4658	5757	41	9048	46,501

Table 18

Mean discharge of South Concho River, Spring, and Dove Creeks
in Acre-feet—1932 - 1936
above main irrigated land bodies
(South Concho at Christoval, Texas, corrected for diversion above,
plus Spring Creek at Tankersly, Texas)
Contributing drainage area — 1168 square miles

Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Ann.
3202	3286	3187	3126	2576	2271	3278	10,999	5078	5802	2109	8302	53,216

In summary it should be pointed out that the drainage area of the South Concho River proper yields considerably more water per unit of area than do the basins of Spring and Dove Creeks. From Tables 9 and 10 , preceding, and previous discussion it has been shown that the mean annual yield of the South Concho above Christoval, Texas, amounts to 59.6 acre-feet per square mile; also that the combined yield of Spring and Dove Creeks above Tankersly is equivalent to a production of 37.3 acre-feet per square mile per annum. Preceding

analyses have indicated that the total mean annual yield of the entire area considered approximates 64,414 acre-feet.

In the section of this report relevant to climatological factors the significance of intense precipitation was emphasized. Such intensified rains contribute directly and materially to the high rate of flood discharge from streams of the area. The maximum known discharge for all of the streams concerned occurred in September 1936. The following Table gives the maximum recorded discharge[1] on the several streams involved and on others:

Table 19
THE MAXIMUM FLOOD DISCHARGES

Stream and Place of Measurement	Drainage Area Sq. Miles	Period of Record	Peak Date	Stage & Discharge			Remarks
				Stage in Feet	Discharge Sec. Feet	Ac. Ft./Sq. Mi.	
Concho River near San Angelo	4217	1854- 1936-	8/6/06 9/17/36	47.5 46.6	246,000 230,000	58.3 54.5	Discharges Slope Area Method
Concho River at San Angelo	2535	1854-1936	9/17/36	23.4	111,000	43.8	" " "
Concho River at Christoval	434	1882-1936	9/17/36	20.5	80,100	185.0	" " "
Middle Concho near Tankersly	1128		9/26/36	24.2	35,000	31.0	Determined from rating spillway of dam.
Spring Creek near Tankersly	734		9/17/36	20.6	23,900	23.6	Discharge from well defined rating curve

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[1] U. S. G. S. W. S. Paper 816, P. 135

During extended dry weather there are periods of no flow recorded in all of the streams of the area. Although the recording stations show periods of zero flow this is not exactly true since diversions above the gages take the entire base flow from the springs in the upper portions of the basins. From field observation of low flows it appears that the minimum flow on either the South Concho, Spring, or Dove Creeks seldom falls below six or seven cubic feet per second on each stream.

No data are available from which the quality of surface water in the area may be determined. However, it is known that lands have been under irrigation in the South Concho, Spring, and Dove Creek basins for nearly 50 years and at the present time there is no evidence of harm to the lands irrigated. Tables 11 to 16 in the preceding part of this section indicate, from the amount of return flow, that the re-use of surface water has been of importance for many years and is consequently representative of existing conditions. The re-use of water has thus far shown no concentration of harmful salts on lands under irrigation.

Hydrology - Ground Water

Ground waters occur to some extent in each of the various geologic formations within the South Concho, Spring, and Dove Creek area. The physical characteristics of those formations which carry sufficient water to be relevant to this report have been previously described in the section on "Geology."

Except in the small and specifically limited area (Plate 2) where the Blaine formation of the Permian is exposed, potable ground waters are generally available throughout the entire area.

As previously pointed out in the discussion of geology, the most significant aquifer of the area is the Edwards limestone. A vast plateau, with the Edwards at or near the surface, lies adjacent to the basins on the east, south, and west. Precipitation on the plateau is the origin of ground waters later discharged to streams of the area. Springs, near the base of the Edwards, release a portion of the total natural discharge from the Edwards formation. The quantity of such discharge to the South Concho River, Spring, and Dove Creeks has been observed and measured at various times over a period of years. Considerable variation in spring flow occurs from year to year and from season to season. Like most springs common to streams of west-central Texas, seasonal variation is to be expected because of variable natural discharge through transpiration and evaporation along the outcrops of the water bearing formations. Sufficient data are not available to allow calculation of the variation in spring discharge. Neither are data on record which would permit conclusions correlating rainfall variation with the changing rates of natural discharge. However, miscellaneous observations of spring discharges are herein shown to indicate the quantity and variability of discharge rates.

Table 20

GROUND-WATER DISCHARGE FROM SPRINGS TO SURFACE STREAM BEDS

Stream	Spring Location	Disch. in Sec.-Ft.	Date
South Concho River	Main Spring near Christoval, Texas	10.7*	3/12/25
Spring Creek	Seven Springs near Mertzon, Texas	12.2*	3/6/25
Dove Creek	Main Spring at Source	13.0*	3/4/25
South Concho River	Main Spring near Christoval, Texas	12.4**	3/25/39
Spring Creek	Seven Springs near Mertzon, Texas	13.1**	3/21/39
Dove Creek	Main Spring at Source	8.6**	3/23/39

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* U. S. Geological Survey, W. S.P. 608

** Water Utilization Section, Unpublished

As a source of stock and domestic water ground waters are important to the area. A potable supply of water may be obtained throughout the greater part of the basins at depths which range, locally, from 20 to 200 feet. The only areas of impotable ground water are those at the extreme lower portion of the area, near San Angelo, and below Christoval, where the only ground water available is carried by the Blaine formation of the Permian.

III

PRESENT WATER AND LAND USE

Stock and Domestic Water

Practically the entire supply of water for stock and domestic purposes, in the rural areas of the basins herein discussed, is recovered from underground sources. As pointed out in foregoing sections of this report, an adequate potable supply of water is carried by the formations of the Fredericksburg and Trinity groups which form the competent aquifers of the area.

With the exception of the alluvial stream terraces, farmed under irrigation, the area is largely utilized as a ranching country and as such is apparently quite well supplied with facilities for recovery and use of stock and domestic water. Windmills for water recovery are supplemented in most cases by storage tanks constructed of native stone masonry.

Municipal Water Supply

The city of San Angelo, Texas, obtains its municipal supply by impounding waters of the South and Middle Concho rivers and Spring and Dove Creeks in Lake Nasworthy. This reservoir is located about

six and one-half miles south of San Angelo and immediately below the confluence of the Middle and South Concho rivers. Water supply for the reservoir is composed of surface flow, return flow from irrigated lands upstream, and ground-water discharge to the surface streams involved. The municipal water supply is furnished to San Angelo by the West Texas Utilities Company which owns and operates Lake Nasworthy under an appropriation for water use dated April 15, 1929.

The appropriation grants the right to storage of water in Nasworthy Lake for both municipal and irrigation use, but limits such use to 25,000 acre-feet per annum. The capacity of the reservoir is 10,500 acre-feet, and the amount of land which may be irrigated is specifically limited, in the appropriation, to 5,000 acres.

Records are not available which show the amount of municipal use but, for purposes of this report, it is estimated that annual consumption will approximate 4,200 acre feet. This estimate is based on a municipal population of 25,000 and a daily consumption of 150 gallons per capita.

Irrigation

Irrigation has been practiced in the South Concho River, Spring and Dove Creek basins since the late 1800's on a scale comparable to present practice in the area.

The three basins contain some 7,300 acres of land which are irrigated from gravity diversion ditches or by waters pumped from the stream channels. Present appropriations for irrigation use in the basins above Lake Nasworthy total 14,505 acre-feet per annum. This amount is divided among the three stream basins as follows: Spring Creek, 6,361 acre-feet; Dove Creek, 4,818 acre-feet, and South Concho River, 3,326 acre-feet. In addition to the 14,505 acre-feet of water appropriated for use above Lake Nasworthy, the West Texas Utilities Company was granted an appropriation for total annual storage in and utilization from Nasworthy reservoir amounting to 25,000 acre-feet. This particular appropriation is largely for municipal and industrial use, but also specifically authorizes utilization of sufficient water for irrigation of 5,000 acres of land lying below the reservoir.

Also listed among present appropriations is one granted to the Concho Water Development Company on April 15, 1929, for construction of a reservoir of 200,000 acre-feet capacity. However, this right was granted subject to the rights and priorities of the West Texas Utilities Company and also subject to completion within nine years from date of the permit. Although the appropriation is still listed there is no record of a granted extension in time and it is, therefore, assumed that the permit is now void by reason of non-development.

Tables 21, 22, 23, and 24 list the appropriations for use of water within the basins concerned.

Table 21
SPRING CREEK
Appropriations

Original Applicant	Present Owner	Purpose	Date of Appropriation	Area to be Irrigated (Acres)	Quantity Granted Acre-Feet per Annum	Storage Capacity Acre-Feet
Brooks, J.R.	Brooks, J. R.	Irrigation	Prior to 1913	140	280	
Edwards, J. A.	Ferris, A.	"	" " "	22.4	45	
Hair, John W.	Christopher, C.	"	" " "	15.5	31	
Helmers, Henry	Helmers, Henry	"	" " "	60	120	
Helmers, Adolph	Helmers, Adolph	"	" " "	144	288	
Hudson, Mrs. C. C.	Bryant, M. D.	"	" " "	213	426	
Hughes, Duwain E.	Hughes, Duwain E.	"	" " "	16	32	
James, K. N.	James, K. N.	"	" " "	70	140	
Johnston, W. R.	Lee, J. A.	"	" " "	235	470	
Kight, N. R.	Kight, N. R.	"	" " "	32	64	
Lewis, R. E.	Boles, Mrs.	"	" " "	39.5	79	
Lindley, Mrs. M. E.	Lawhorn , - -	"	" " "	40	80	
Lofton, Mrs. J. H.	Baker, M. C.	"	" " "	320	640	
Middle Ditch Pumping Co.	Middle Ditch Pumping Co.	"	" " "	216	432	
Page, J. R.	Price, Dave	"	" " "	108	216	
Rutledge, J. J.	Rutledge, J. J.	"	" " "	40	80	
Tankersly, Fayette	Tankersly, Fayette	"	" " "	500	1,000	
Thorpe, J. F.	Harney, Harlan	"	" " "	50	100	
Whitaker, C. H.	Whitaker, C. H.	"	" " "	22	44	
Metcalfe, C. B.	Metcalfe, C. B.	"	" " "	500	1,000	
Nasworthy, J. R.	Nasworthy, J. R.	"	" " "	30	60	
Hall, R. D.	Hall, R. D.	"	May 26, 1924	160	—	
Hughes, D. E.	Hughes, D. E.	"	June 30, 1924	56	—	
Russell Bros.	Whitaker Bros.	"	Jan. 26, 1925	63	126	
Motl, Emil	Motl, Emil	"	Feb. 16, 1925	64	128	
Rust, J. Y.	Rust, J. Y.	"	June 29, 1925	160	320	
Metcalfe, C. B.	Metcalfe, C. B.	"	Mar. 28, 1927	80	160	
Williams, D. H.	Hall, R. H.	"	Pending			
			Total	3,396.4	6,361	

Table 22
DOVE CREEK
Appropriations

Original Applicant	Present Owner	Purpose	Date of Appropriation	Area to be Irrigated (Acres)	Quantity Granted Acre-Feet per Annum
San Jose Irrigation Co.	San Jose Irrigation Co.	Irrigation	Prior to 1913	1,500	3,000
Tweedy, Joseph	Tweedy, Joseph	"	" " "	275	550
Box, John R.	Walker, L. A.	"	" " "	500	1,000
Duncan, L. P.	Duncan Estate	"	" " "	70	140
Forrester, T. H.	Foster, E. E.	"	" " "	4	8
Halbert, B. F.	Gilman Estate	"	Aug. 6, 1917	60	120
		Total		2,409	4,818

Table 23
SOUTH CONCHO
Appropriations

Original Applicant	Present Owner	Purpose	Date of Appropriation	Area to be Irrigated (Acres)	Quantity Granted Acre-Feet per Annum	Storage Capacity Acre-Feet
Brown, R. Wilbur	Brown, R. Wilbur	Irrigation	Prior to 1913	94	188	
Goldwire, H. C.	Kirk, C. B.	"	" " "	100	200	
Jemeyson, E. J.	Jemeyson, E. J.	"	" " "	80	160	
Mims, Oscar	Mims, Oscar	"	" " "	200	400	
St. John, L. W.	Willbanks, --	"	" " "	5.75	12	
Sims, J. T.	Daniel, --	"	" " "	65	130	
Warnock, H. C.	Findlater, --	"	" " "	800	1,600	
West, A. D.	West, A. D.	"	" " "	300	600	
Concho Water Development	Concho Water Development	Irrigation & Power	Apr. 15, 1929	34,975	200,000	200,000
West Texas Utilities	West Texas Utilities	Municipal Supply & Irri,	Apr. 15, 1929	5,000	25,000	10,500
Brown, K. W.	Daniel, --	Irrigation	Mar. 31, 1930	10	20	
Montgomery, T. P. & Johnson, S. W.	Montgomery & Johnson	"	Nov. 30, 1931	7.97	16	
		Total		41,637.72	228,326	210,500

Table 24
SUMMARY OF IRRIGATION USE

	South Concho	Dove Creek	Spring Creek
Number of Gravity ditches	2	5	6
Number of units on gravity ditches	18	13	46
Number of units irrigation by pumps	11	7	21
Total units	29	20	67
Acres Irrigated — gravity system	1,135	1,912	1,319
Acres Irrigated — pump system	746	608	1,639
Total acres irrigated	1,881	2,520	2,958
Average size farm unit — gravity	63	147	29
Average size farm unit — pump	68	87	78

Approximately 60 per cent of all land irrigated in the South Concho, Spring, and Dove Creek basins is served by direct diversion of water through gravity canals. Diversion dams for the gravity distribution systems vary from loose rock and brush structures to concrete Ogee sections. Water is diverted through the main canals throughout the entire year and such practice has, in most cases, eliminated use of headgates. The practice of continual diversion has also led to growth of trees, brush and heavy grasses along the banks of canals and heavy growth of mosses and other water plants within the ditch sections. The resultant diminution of canal carrying capacity and velocity is conducive to heavy ditch loss through transpiration, evaporation, and seepage. Present appearance of all such distribution systems in the area indicate that little, if any, maintenance work is done on distribution ditches and laterals.

In addition to lands irrigated through direct diversion canals there is a considerable acreage served by pumping systems which take their water supply from small channel reservoirs created by low overflow dams. These channel reservoirs have only sufficient storage capacity to serve as a pumping pool. Waters thus pumped are lifted and discharged to flumes of adequate height, at the stream bank, to produce heads for irrigation on lands above and adjacent to the streams. Because the pumps are operated only at intervals and the distribution of pumped water is generally confined to a smaller acreage, the ditches and laterals under the pumping systems are maintained far better than those of the direct diversion systems.

The total acreage of land under irrigation in each of the three basins considered is divided as follows: South Concho River 1,881 acres, Dove Creek 2,520 acres, and Spring Creek 2,958 acres. As previously pointed out, the total appropriations for water use above Lake Nasworthy total 14,505 acre-feet per annum. To this amount must be added the appropriation of the West Texas Utility Company for utilization of an additional 25,000 acre-feet. Hence the total appropriated water supply including storage and use from the Nasworthy reservoir is 39,505 acre-feet annually. In the summary of the Water Supply Section of this report, it was estimated that the total mean annual yield of the area embraced in this report would approximate 64,414 acre-feet. It appears, therefore, that at least the annual contributing water supply of the South Concho River, Spring, and Dove Creeks combined, is adequate to fulfill the appropriations for water use on all three of the streams. It should be added, however, that this report does not consider the Middle Concho River basin but that an additional supply of water from the Middle Concho basin is also available at Lake Nasworthy, and consequently is an additional aid to fulfillment of the appropriations for storage and use of the Nasworthy reservoir water.

As was stated above, the amount of irrigated land on the South Concho River is approximately 1,881 acres, and from Table 6 in the Water Supply Section it is shown that mean annual water supply above all major diversions is approximately 25,845 acre-feet. Thus, there is little question regarding adequacy of total supply for the irrigated lands of the South Concho basin.

Irrigated lands in the Spring and Dove Creek basins combined amount to 5,478 acres and the average annual water supply on Spring Creek below the confluence with Dove Creek is approximately 27,371 acre feet per year. From the indications given by annual supply there appears to be sufficient water available for irrigation of lands in the Spring, and Dove Creek basins. However, the basin of Dove Creek is considerably smaller than that of Spring Creek and the irrigation area is approximately the same size. Although the size of Dove Creek basin has not been accurately determined, measurements from base maps of the area indicate it to be an area of about 271 square miles. Assuming that the annual per square mile yield of Dove Creek is about the same as that of Spring and Dove Creeks combined; namely, 37.3 acre-feet, the average annual yield for the Dove Creek area would be 10,108 acre-feet.

Although available data would indicate that water supply in each of the streams involved is sufficient for more than adequate irrigation of lands within those basins, it should be pointed out that all of the listed appropriations for the use of water within the basins themselves and downstream from the area considered may or may not be a full and accurate listing of all rights involved. The Texas Board of Water Engineers, (the administrative water agency of the state), was not established until 1914. Previous to that time a great many water users had constructed and were using storage and diversion systems for irrigation use. At the time of establishment the Board immediately set about to make listings of appropriations

on all the streams of Texas. This, however, was a task of such proportions that it is still in process, and it is likely that many appropriations, particularly downstream from the basins involved, may not as yet be a matter of record. A summary of appropriations on the Colorado River and tributaries, of which the South Concho and tributaries are a part, indicates that much more water is appropriated for the basin as a whole than is actually available therein. Only a detailed study of all rights to the use of water could establish those portions of the basin wherein shortages are most likely to occur.

Ground Water

In previous portions of this report it has been stated that the use of ground water within the area to which this report relates is confined to recovery of ground water for stock and domestic purposes only. From field observations in the area during the early part of 1939 it is concluded that facilities for recovery of stock and domestic water are well distributed throughout the area. Ground waters are generally available for such use in all but two isolated portions of the area. Depths from which it is recovered vary locally from 20 to 200 feet, and all recovery is made by windmill. Since the total quantity of water used for stock and domestic purposes is small in relation to the amount of water available in the aquifers of the area, no estimate is herein made of the quantity in or draft from the water bearing formations. No ground waters are recovered for irrigation, industry or power use.

Floods and Flood Damage

Intense rainfalls of short duration frequently occur during the summer months, and resultant run-off often causes considerable damage in the basins involved in the area. No estimate of such damages was made for this report.

From records available, the most damaging floods within the South Concho, Spring, and Dove Creek basins occurred in September, 1936, at which time the cumulative flow of the South, Middle, and North Concho rivers combined to do extensive damage in the city of San Angelo and in areas downstream along the main Concho River. The greatest damage within the portions of the basins herein considered occurred to railway, highway, and irrigation structures along the channels of those streams. Many of the diversion works and irrigation distribution systems were entirely destroyed by the 1936 flood. Considerable damage, of course, is caused by overflow on the farm lands adjacent to the stream channels but no monetary estimate is available of the extent of such damage.

Land Use

Based upon reconnaissance field estimates and estimates by county officials, the total area of pasture and grazing lands within

the South Concho River, Spring, and Dove Creek basins is approximately 860,000 acres. This area covers much of the rougher land in the middle and upper portions of the drainage areas and includes practically all land in the Valera soils group.

The remainder of the area under consideration, or about 40,000 acres, is under cultivation. Of this acreage 7,300 acres are irrigated and 32,700 acres are farmed as dry land. Cotton, wheat, and grain sorghums are the principal dry land crops, while hay, cotton, maize, pecans, and some specialty crops are produced under irrigation.

Present Type of Farming

As a whole the area embraced by the basins of the South Concho River, Spring, and Dove Creeks may be classified as a diversified livestock and farming area. Cotton and wheat constitute the principal cash crops grown in dry land areas. The principal cash crops grown under irrigation include cotton, hay, corn, potatoes, pecans, and some vegetable crops. The area farmed for cash crop production is confined to the irrigated areas and to the limited areas of Abilene and Roscoe soils lying adjacent to the irrigated sections.

Feed crops are produced in scattered areas throughout the basins and are utilized in stock feeding operations on general farming units.

Ranching constitutes the major agricultural operation within the area with sheep, goats, beef cattle, and some dairy cattle being raised.

Irrigation farms produce hay and other feed crops which are readily marketable to the livestock industry. In addition, cash crops such as cotton, pecans, potatoes, and truck crops are all grown to some extent on irrigated lands.

Land Ownership and Land Values

Up to date data on land ownership are not available but general indications are that approximately 55 per cent of the entire area is owner operated. This is particularly true of the large livestock and irrigated units. The remainder of the area is operated by part owners and tenants.

Little or no concrete data are available on land values because of a relatively slight turnover of land. Local real estate dealers quote grazing lands from 7 to 15 dollars per acre and irrigated lands from 75 to 200 dollars per acre, but report little movement at these asking prices.

From meager data and general observation, land productivity does not seem to have changed appreciably over a period of years. Irrigated lands appear to be producing much the same as in previous years with crop yields varying with moisture conditions and with availability of irrigation water.

Pasture lands have been overgrazed in parts of the area, but no permanent damage seems to have been done to date. Range carrying capacity varies locally but, in general, range conditions appear to allow the pasturing of about 40 to 50 head of cattle per section.

Area Misuse and Maladjustment

Data pertinent to the various factors which usually indicate misuse of the resource or maladjustment tend to show that the South Concho River, Spring, and Dove Creek area is in comparatively good condition. There has been practically no land abandonment within the area and Federal grants and relief are not prevalent.

In general the Federal Land Bank and others have had few loan defaults and little delinquency. The Farm Security Administration has about 50 standard loan clients in the area but none on grants.

Direct and work relief has been largely confined to persons residing in cities and towns in, or near, the area.

IV

PROJECTED ADJUSTMENT AND FUTURE AREA UTILIZATION

Area Utilization

Land Utilization - As shown in the foregoing section of this report concerning present use of the area under consideration, it was pointed out that only about 5 per cent of the entire area is under cultivation. It was further noted that those areas not under cultivation are almost entirely confined to the alluvial fills of the basins and to the terraces immediately adjacent thereto. Located within these areas are those groups of soils previously discussed which are most adaptable to cultivated farming. No additional lands are recommended for tilling.

About 95 per cent of the area is not utilized for grazing purposes, and although it has been overgrazed to some extent, it is felt that no change in type of use should be made within the grazing areas.

No additional lands are recommended for irrigation farming because of factors which will be discussed in the following section on proposed utilization of water within the area.

Water Utilization

Stock and Domestic Use - Throughout the entire portion of the South Concho River, Spring, and Dove Creek basins, which is utilized

in ranching operation, stock and domestic waters are obtained from underground sources. Lacking specific information on ownership of land, it is impossible in this report to recommend specific installations of additional windmills or storage tanks for recovery and utilization of stock and domestic water supplies. Since, however, ground waters are generally available throughout the grazing portion of the area, it may be recommended that in those specific localities where the operations agency finds that either new installations or rehabilitation of older installations are desirable and will improve range use, they may and should be furnished. It is probable that there will be found certain areas where a more efficient distribution of stock water supply will be desirable and it is recommended that facilities for recovery and use of stock water be furnished in all such instances.

Municipal Works - In discussing the present utilization of water it was shown that a portion of the water supply derived from the South Concho River, Spring, and Dove Creeks, is utilized for municipal and industrial purposes by the city of San Angelo, Texas. Such water supply is furnished to the city by the West Texas Utilities Company which has an appropriation for storage and utilization of 25,000 acre-feet per annum. It has previously been estimated that the annual domestic supply for San Angelo amounts to approximately 4,200 acre-feet per annum. In addition to this amount the appropriation for West Texas Utilities Company provides for use of sufficient waters to irrigate 5,000 acres of land below Lake Nasworthy.

Assuming a gross duty of 2 acre-feet per annum, the annual consumption for irrigation use, when and if developed, should not exceed 10,000 acre-feet per annum. Assuming that this acreage will be developed and allowing for an increase in population in the city of San Angelo, it appears that the appropriation of 25,000 acre-feet per annum would be adequate to fulfill demands for some time to come.

Irrigation - Operating under present conditions some lands now served by surface irrigation works almost always suffer from shortage of water during the latter part of the irrigation season. Facilities for diversion and distribution of water have been discussed in previous sections of this report, and it hasbeen pointed out that considerable difficulty has been encountered through inadequate maintenance of present works. The present canals through which irrigation waters are diverted are of necessity constructed on relatively low gradients and due to mild weather throughout much of the winter season water is diverted on a year around basis. Little or no attempt has been made to maintain present distribution systems in a manner conducive to efficient distribution of irrigation supplies.

About the only shortage of water on any of the three streams involved is suffered by irrigators at the extreme lower ends of the various diversion systems. This condition occurs largely due to the fact that the base flow of all streams naturally decreases to its minimum during the summer months of July and August. Consequently, less divertible flow is available during that time of the year.

With the divertible flow cut to a minimum, and with diversion canals of low gradient filled with moss and other water plants in the canal zone and with trees and shrubs crowding the banks, the amount of water loss through transpiration approaches its maximum about the same time as base flow reaches its minimum. In addition, the plant growth within and along the banks of the canals materially diminishes the velocity within the canal section. It is, therefore, obvious that much of the flow which is actually diverted is lost through transpiration and evaporation or, because of slow velocity, is lost by return flow to the stream channels. Hence, little or no water reaches those lands which lie at the lower extremities of the various diversion systems.

Records of stream discharge presented in the water supply section of the report show that the total annual supply available within each of the basins concerned is adequate for the amount of land irrigated within each basin. Consequently, it must be concluded that inadequate irrigation supply is largely the result of operation rather than a shortage of annual supply available from the streams themselves.

The custom has long been established of diverting water throughout the entire year, not for the purpose of irrigation but in order that water may be furnished to livestock which are pastured in the valleys during the winter months. Apparently this is the primary reason for year around diversion since little or no spreading of water on land is done between late October and the early part of March. Since, in the alluvial valleys, an adequate supply of

ground water is readily available at depths seldom exceeding 100 feet, it would be a relatively simple matter to fulfill stock water needs through recovery of ground water by windmills. By so doing canal flows could be cut off entirely for a period of several months and thus allow a period during which canals and laterals could be cleared of all debris collected during the previous irrigation season.

As may be noted from the tables listing the appropriations to use of water, each appropriator is given a maximum annual allowance for diverted water. However, it is obvious that under the present system of diversion these specific amounts have been, in many cases, far exceeded although all such diverted water is not applied to land. Past records of irrigation requirements at several locations in the Plains area would indicate that a gross water requirement of about 1.75 acre-feet per acre per year should be sufficient for the area under consideration. The following table indicatesgross requirements which have been more or less established in areas comparable to the one under consideration.

MONTHLY AND SEASONAL IRRIGATION REQUIREMENTS

Monthly Percentages of Seasonal Irrigation Requirement												Seasonal Irrigation Requirement in Acre-Feet per Acre
Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
..	..	4	7	14	25	25	15	9	3	..	..	1.75

Along with a better system of maintenance it might be necessary in the drier years to work out a system of water rotation among

users on the various streams which would allow all irrigated lands an equal opportunity in acquiring water supply adequate for crop production.

Until such time as some system of cooperative maintenance and distribution is worked out, which at least approaches a more beneficial utilization of the supply now available, it is not feasible to recommend irrigation of additional lands.

Ground Water - Exclusive of developments which may be advantageous for stock and domestic consumption of water no ground-water development is recommended. As previously pointed out, however, there may be a few localities where installation of new facilities for recovery of stock water may be desirable. The operations agency may also find it desirable to rehabilitate some existing facilities or provide more adequate storage for existing recovery facilities, and in such cases it is recommended that these developments be made.

Recovery of ground water for irrigation use is not recommended because physically irrigable lands may be more economically irrigated with available surface water supplies.

Sept # 5

1939 Sept # 5

SOUTH CONCHO RIVER,
SPRING AND DOVE CREEK DRAINAGE BASINS
IN
WEST—CENTRAL TEXAS

TOPOGRAPHY & CLIMATOLOGY

Prepared by
WATER UTILIZATION SECTION
DIVISION OF LAND ECONOMICS
BUREAU OF AGRICULTURAL ECONOMICS
UNITED STATES DEPARTMENT OF AGRICULTURE
Under the Provisions of the
Water Facilities Act Pub.
Law No. 399 75th Congress

MAY, 1939

Map compiled from USGS Quadrangle sheets and County Highway Maps

PLATE NO. 1

SOUTH CONCHO RIVER,
SPRING AND DOVE CREEK DRAINAGE BASINS
IN
WEST—CENTRAL TEXAS

GEOLOGY

Prepared By
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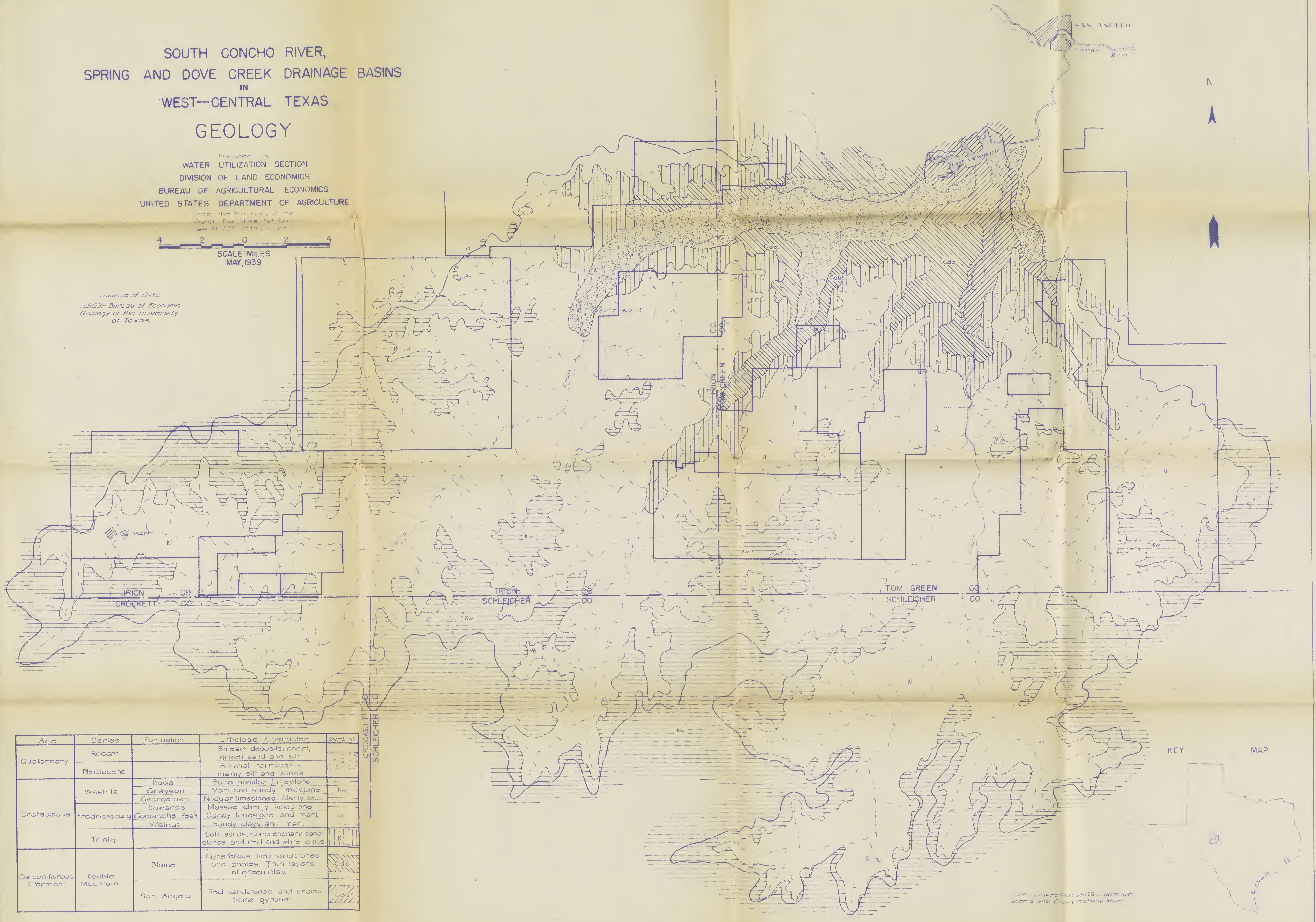

MAY, 1939

Source of Data:
U.S.G.S.- Bureau of Economic
Geology of the University
of Texas.

Age	Series	Formation	Lithologic Character	Symbol
Quaternary	Recent		Stream deposits; chert, gravel, sand and silt	Q
	Pleistocene		Alluvial terraces - mainly silt and sands	
Cretaceous	Washita	Buda	Sand, nodular limestone.	Kw
		Grayson	Marl and sandy limestone.	
		Georgetown	Nodular limestones - Marly beds	
	Fredricksburg	Edwards	Massive cherty limestone.	Kf
		Comanche Peak	Sandy limestone and marl.	
		Walnut	Sandy clays and marl.	
	Trinity		Soft sands, concretionary sandstones and red and white clays.	Kt
Carboniferous (Permian)	Double Mountain	Blaine	Gypsiferous, limy sandstones and shales. Thin layers of green clay.	Cdb
		San Angelo	Red sandstones and shales Some gypsum.	Csa

Base compiled from USGS Quadrangle sheets and County Highway Maps

1939 Sept # 5

SOUTH CONCHO RIVER, SPRING AND DOVE CREEK DRAINAGE BASINS IN WEST—CENTRAL TEXAS

WATER RESOURCES

Prepared by

WATER UTILIZATION SECTION
DIVISION OF LAND ECONOMICS
BUREAU OF AGRICULTURAL ECONOMICS
UNITED STATES DEPARTMENT OF AGRICULTURE

Under the Provisions of the
Water Facilities Act Public
Law No. 399 75th Congress

4 2 0 2 4
SCALE: MILES
MAY, 1939
SAN ANGELO
①
②
Concho River
③
Middle Concho
④
⑤
N
Barnhart
Sh
IRION CO
CROCKETT CO
IRION CO
SCHLEICHER CO
TOM GREEN CO
SCHLEICHER CO
IRION CO
TOM GREEN CO
CROCKETT CO
SCHLEICHER CO
KEY MAP
GROUND WATER
Potable groundwaters available in quantities sufficient for stock and domestic use
Impotable groundwaters unfit for stock and domestic use
SURFACE WATER
60,000
10,000
Mean annual stream discharge in acre feet.
1 U.S.G.S. Geological Survey Gaging Station
Base compiled from USGS quadrangle sheets and County Highway Maps

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